Space Weather Technical Forecast

Issued on Tuesday 21 January 2025 at 00:53 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: M-class flares likely, with a slight chance of X-class flares. Chance of Active electron fluence.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Low, with a peak C6.3 flare at 20/1315 UTC from AR3968. AR3961 remains the largest sunspot group. A growth trend is evident, yet flare activity remains largely muted, however, the magnetic configuration of the sunspot is complex, now with a Beta-Gamma-Delta classification, as weak delta regions have developed around the intermediate portion. AR3964 and AR3959, are both moderately sized spots in the northeast, neither of which have shown any significant change in recent hours. Confidence in the magnetic configuration of AR3968 is low, given increased foreshortening as it approaches the western horizon. All remaining spots are small and have shown little change.

No clear Earth-directed CMEs have been observed, though a filament eruption from the SE around 20/1954UTC is under review.

Solar Wind / Geomagnetic Activity: Ongoing fast winds from CH09/- were observed. Solar wind speed, as measured by ACE and DSCOVR increased from slightly elevated to strong levels, reaching 600-650km/s by the end of the period. Density was at or below average. Interplanetary Magnetic field, Bt, was Weak to Moderate, ranging from 5-10nT, with the north-south component varying between +9/-8nT, with no single orientation favoured. Phi angle was mainly negative (towards the Sun). Geomagnetic activity was Quiet to Active (Kp2-4).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) at GOES18 was at Background. High energy electron flux (greater than 2MeV) at GOES16 was mainly Moderate, peaking 791pfu at 19/1845UTC. The associated 24-hour fluence persisted below the Active threshold, reaching 2.32e7 integrated pfu at 20/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate activity is forecast, with isolated M-class flares likely and a slight chance of X-class flares.

Solar Wind / Geomagnetic Activity: There are no CME arrivals expected at Earth, however a glancing impact from the CME early on 18 Jan cannot be completely ruled out early day 1 (21 Jan). Otherwise, current strong fast winds from CH09/- are expected to continue before gradually

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easing, likely becoming near background by the end of day 3 (23 Jan). Mainly Quiet to Unsettled geomagnetic activity is expected, with a chance of Active intervals day 1 (21 Jan).

Energetic Particles / Solar Radiation: GOES18 high energy proton flux is expected to be at Background, but with a slight chance of enhancements exceeding the S1 Minor Radiation Storm threshold should any notable flares occur. GOES16 high energy electron flux is forecast to be Moderate to High, although the longevity of the periods of High is low confidence. The associated 24 hr fluence is expected to remain below the Active threshold (1e8 integrated pfu), but with a chance of rising above days 1 and 2 (21-22nd Jan).

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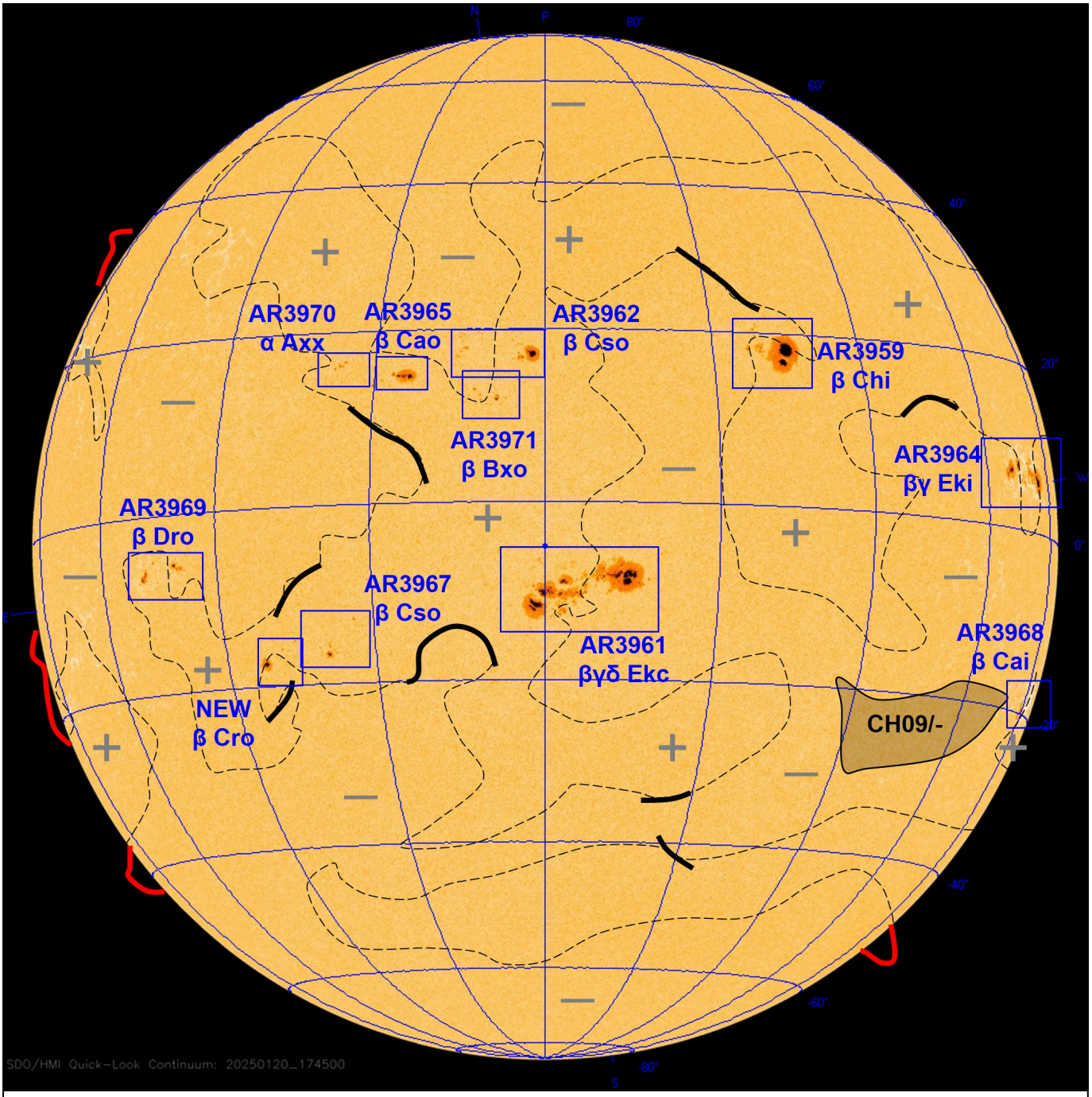
Figure 1: Solar synoptic map valid 20/1745UTC



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

There are no CMEs expected to impact Earth. However a weak eruption from AR3964 early on 18 Jan is expected to pass close to Earth, likely just ahead and north of its orbit. This has a small chance to give a very slight glancing impact on day 1 (21 Jan), as it passes nearby.

Solar winds are currently dominated by fast wind from the longitudinally wide CH09/-. Observed winds from this feature have increased to become strong (with speeds around 600-650km/s). These fast winds are expected to continue on day 1 (21 Jan), before starting to erratically easing, likely becoming near background by the end of day 3 (23 Jan). This prolonged enhancement is supported by MOSOWC Enlil, although is now slightly underestimating the strength of the solar wind. Given current observations, the forecast broad decline in the coming days is accepted.

Largely Quiet to Unsettled geomagnetic activity is expected, with a chance of Active intervals and a slight chance of G1/Minor geomagnetic storms. These most likely late on day 1 (21 Jan), mainly if any CME glance occurs.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	**G1 to G2**	No	20	5	1	1
Strong	**G3**	No	1	1	1	1
Severe	**G4**	No	1	1	1	1
Extreme	**G5**	No	1	1	1	1

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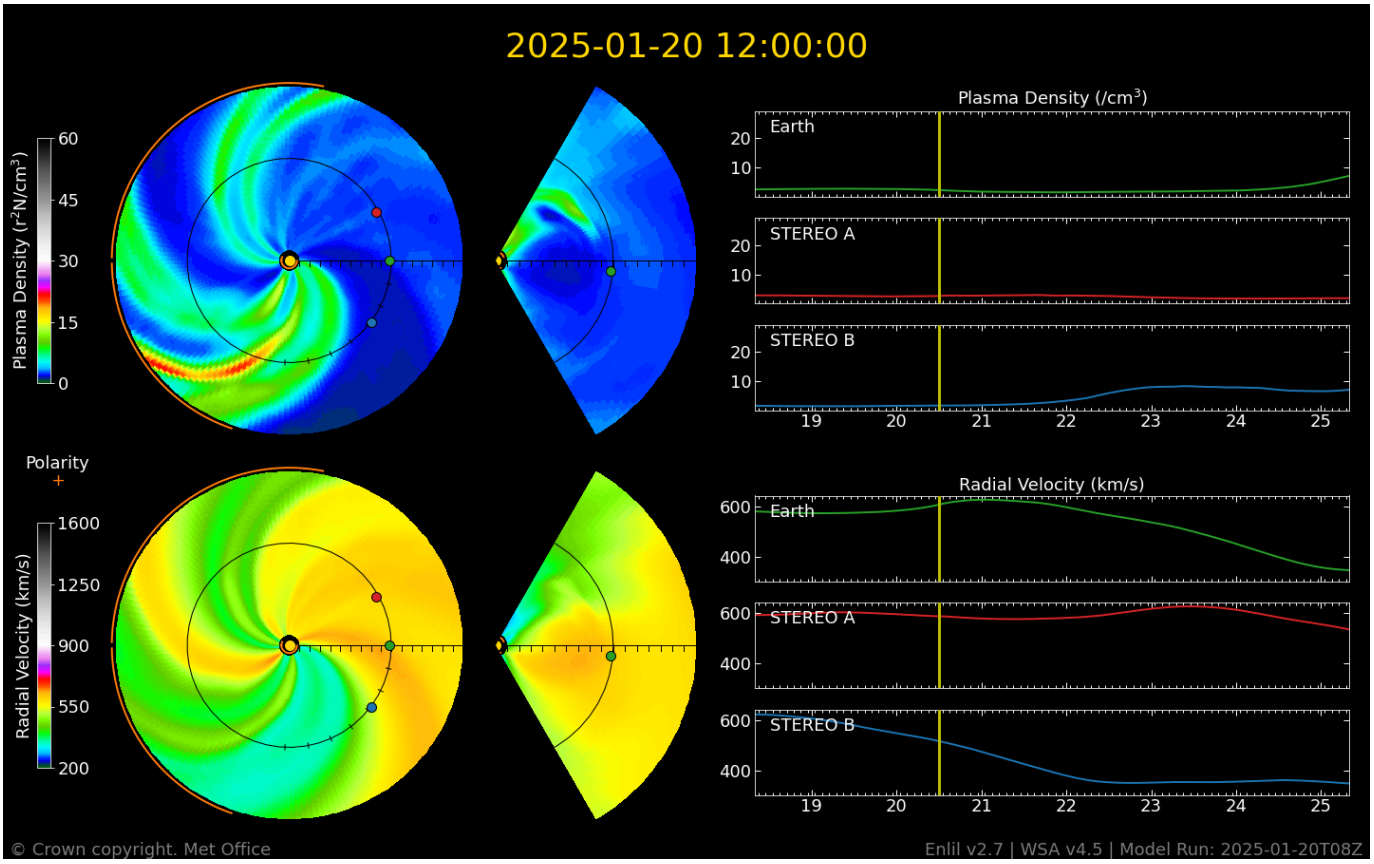
Figure 2: Latest MOSWOC Enlil showing connection to HSS of CH09/-. Speeds currently slightly underestimated compared to observed values at L1.



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Radio Blackouts - X-Ray Flares

Moderate activity is forecast, with isolated M-class flares likely and a slight chance of X-class flares.

There are eleven sunspot regions on the Earth-facing disc. AR3961 remains the largest sunspot group. A growth trend is evident, yet flare activity remains largely muted, however, the magnetic configuration of the sunspot is complex, now with a Beta-Gamma-Delta classification, as weak delta regions have developed around the intermediate portion. AR3964 and AR3959, are both moderately sized spots in the northeast, neither of which have shown any significant change in recent hours. Confidence in the magnetic configuration of AR3968 is low, given increased foreshortening as it approaches the western horizon. All remaining spots are small and have shown little change.

Of the more significant sunspot regions currently on the disc, AR3964 is the most notable to rotate over the western limb during the period, taking place on day 2 (22 Jan). Although a number of returning regions are expected in the forecast period, far sided helio-seismic soundings do not currently infer the presence of any strong active regions close to the eastern limb. On balance this means a slight reduction of forecast flare probabilities during the period, independent of any development of the sunspots currently on the facing-disc.

X-Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 (M Class)	No	70	70	70	60
Very Active	R3-R5 (X Class)	No	20	20	20	15

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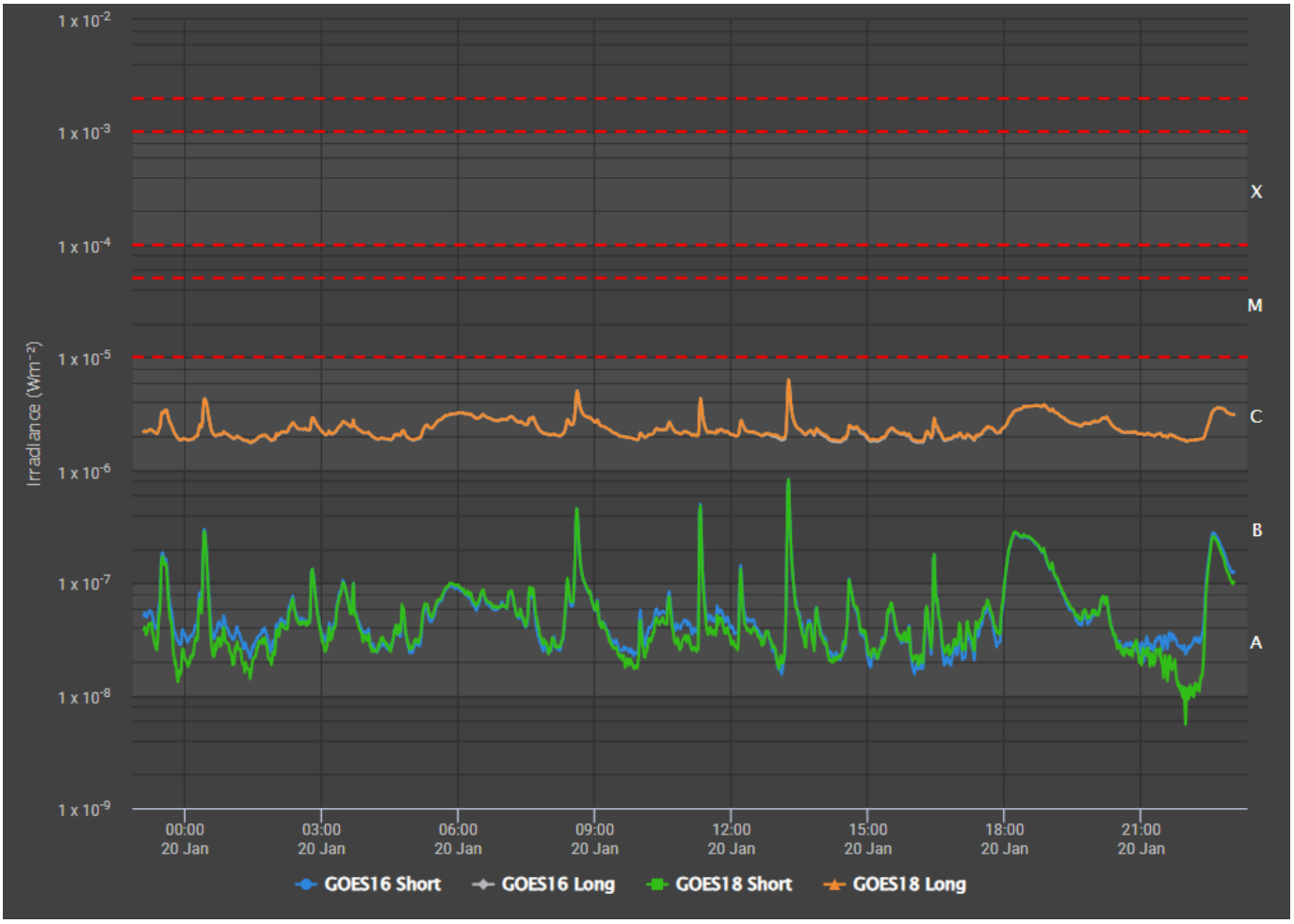
Figure 3: 24 hour X-Ray trace



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Solar Radiation Storms (High Energy Protons)

GOES18 high energy proton flux has persisted at Background levels. There is a slight chance of enhancements exceeding the S1 Minor Radiation Storm threshold should any notable flares occur. This includes any activity from AR3964, which is in a well-connected location in the northwest disc, or from AR3961 near the central meridian in the southern hemisphere.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	20	20	20	20
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons (≥ 2MeV)

High energy electron flux observed at GOES16 has been at mostly Moderate and briefly High levels in the past 24 hours, as a result of the recent extended period of slightly elevated to elevated solar winds. As these winds ease, any charging of the Radiation Belt is likely to expand outward, with the diurnal peak period at GEO likely to reach High. However, the longevity of these periods of High flux is currently low confidence due to the lack of any notable geomagnetic activity leading to some uncertainty with the extent of any charging. Furthermore, there is a slight chance of a glancing CME arrival early day 1 (21 Jan), which could help to drop out the observed flux at GEO.

Subsequently, the associated 24 hr fluence has a chance of becoming Active (1e8 integrated pfu) days 1 and 2 (21-22 Jan), then a slight chance thereafter. MOSWOC REFM has a similar rising trend, and is currently deemed to give reasonable guidance.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	30	50	20	1
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

Figure 4: 24 hour Electron Flux.

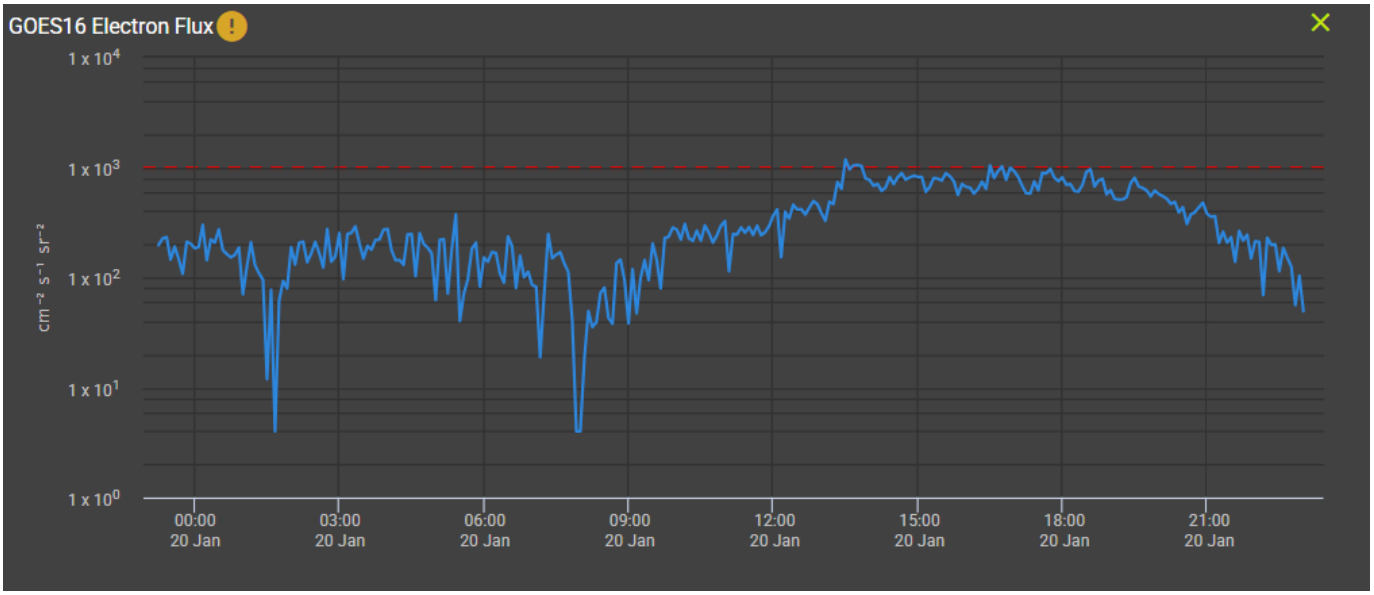

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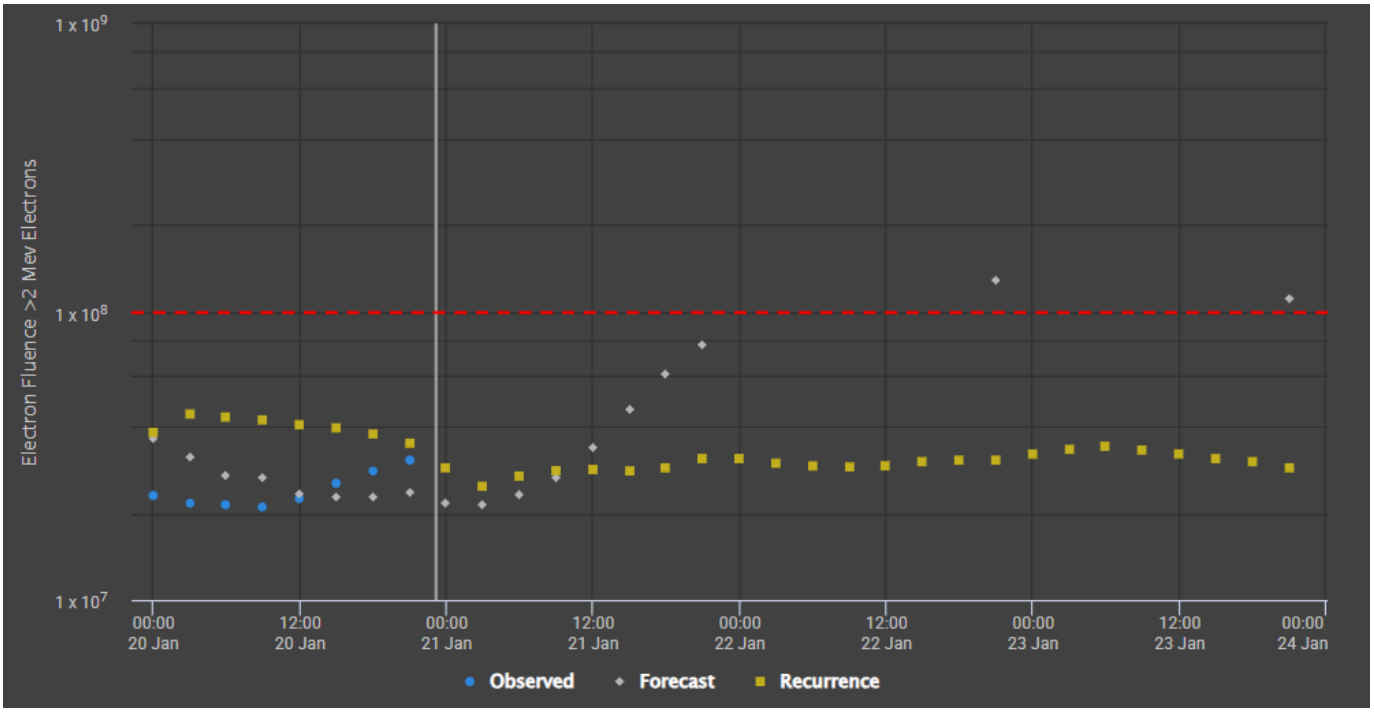
Figure 5: MOSWOC REFM showing the integrated flux/fluence forecast, observations and recurrence.



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